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An Experimental Study of In-Service Teacher Training to Promote Inductive Teaching and Creative Problem Solving.

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This latest in a series of studies (of conditions which support creative problemsolving activity of gifted children) attempted to assess the immediate impact of an inservice training program to promote inductive and nondirective teaching behaviors. Subjects were 160 teachers (124 who participated in the training program and 36 constituting a control group: half from disadvantaged and half from advantaged schools) obtained from Chicago grade schools through three processes of random selection and assignment. Trained raters using Flanders' interaction analysis were employed to assess each teacher's behavior, pre and post, as 15 to 20-minute lessons were conducted. In all three dimensions analyzed--teacher talk, indirect teacher talk, and content--experimental teachers showed significantly greater change toward inductive teaching styles than control teachers, whether they began the project with relatively high or low patterns. The same dimensions of teacher behavior were assessed when the teachers conducted a lesson which involved a problemsolving task of a non-academic kind using materials designed to encourage display of whatever inductive potential they might possess. All teachers showed significantly greater inductive tendencies in their behavioral response to the specially constructed lessons than they showed in reponse to the earlier regular academic ones. (Implications are discussed and hypotheses for further study suggested.) (JS)

Research Report:

"An Experimental Study of In-Service Teacher Training to Promote Inductive Teaching and Creative Problem Solving."

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"An experimental Study of In-Service Teacher Training to Promote Inductive Teaching and Creative Problem Solving."

For the past six years the Chicago public schools, through the cooperation of the Department of Gifted Children, State Superintendent of Public Instruction, State of Illinois, have examined experimentally conditions which support the creative problem-solving activity of gifted children. This six year investigation has been concerned with five interrelated dimensions:

1. The identification and measurement of pupil creative problem solving behavior.
2. The use of instructional materials to evoke pupil creative problem solving.
3. The use of certain teaching behaviors to further encourage creative problem solving.
4. The development of in-service teacher training procedures to promote these kinds of teaching behaviors, largely, inductive and non-directive.
5. Experimental assessment of the immediate impact of the in-service program developed, upon the existant attitudes, ideas and teaching behaviors of the teacher involved.

It is this last phase (number 5) that I shall discuss with you in the present paper. Reports relating to earlier work have been completed, and can be made available on some basis to interested educators.

Early experiences in the project pointed to the decisive influence of teacher behavior, upon the essential character of the on-going learning process. Almost without exception, teacher style -- the role assumed by the teacher as she communicated with children at both verbal and non-verbal levels -- appeared to be the critical factor in determining the relative degrees of teacher and pupil participation in shaping and directing the learning process. Since the free exercise of creative problem-solving skills by children required significant degrees of pupil

involvement, the attention of our staff was drawn increasingly to ways in which teacher behaviors, so vital for the support of problem-solving activities, could be encouraged. Such a program, to be effective, must communicate to teachers who at that time, were observed to spend at least 60% - 70% of their time in teacher-directed, didactic kinds of classroom behavior.

Such a program was developed, and has been engineered into operational form, with careful descriptive data available on all of its main phases. It thus constitutes a clearly defined experimental treatment -- somewhat of a rarity in practical school research. Underlying its own operation is a largely inductive involvement of project participants in the kinds of experiences which should permit the participants themselves to explore freely important questions about children and learning, and to discover the importance their own teaching behaviors have upon the ways in which children learn.

Before summarizing some of the empirical data collected and analyzed as evidence of program impact, it is important to define with greater precision, two related concepts which are central to project objectives: "pupil creative problem-solving," and "inductive teacher behaviors."

As defined by this study pupil creative problem-solving is self-directed, functional behavior, which satisfies the demands of a new equivocal situation, generating unprecedented responces through both divergent and convergent thinking.

Divergent thinking consists of the perception of new functions for

the elements within a problem field which permits re-organization of the field in such ways as might generate a higher frequency of possible solutions. The ability to fuse the new functions of elements perceived within the problem field, which focus on a solution which meets the conditions of the problem, requires convergent thinking.

Inductive teacher behavior was defined in terms of identifiable, recurring teacher roles. The following behavioral patterns appeared basic to an inductive style:

1. Encouraging each student to contribute his own thoughts to the group effort.
2. Condoning what a child is trying to do even though effort results in failure -- immediate, sole objective is not "right answer" dissemination.
3. Attempting to incorporate the pupil's own interest, goals and expectations into class discussion.
4. Encouraging students to draw upon their own personal past experience as a basis for their beliefs.
5. Encouraging individual conviction and defense of own ideas.
6. * Encouraging students to listen critically to what students and teachers are saying.
   * Encouraging pupils to react directly to other pupil's comments so long as they can be heard by the group.
   * Encouraging pupils to react indirectly (through the teacher) to other pupil's comments.
7. * Encouraging students to pass judgment on what the teacher has said.
   * Encouraging students to pass judgment on what students say.
8. Encouraging students to persevere in a self-directed course of action in the face of group uncertainty.
9. Asking questions for which there are no specific answers already obvious to the class.

Summing up, a central theme is the encouragement of student-directed learning, with a teacher becoming more of a moderator and provoker, than an authority vested with all of the right answers. It was hoped that teacher understanding, attitude and commitment, and actual classroom behavior would all advance significantly and measurably toward inductive styles as a result of this program.

In selecting the sample of schools and teachers who became a part of this project, all public elementary schools in Chicago having grade levles 3-8, were stratified according to the socio-economic character of the local community which they served. Socio-economic status was determined by income, rate of unemployment, and educational achievement as listed in the 1960 U. S. Bureau of Census's statistics. Eligibility for ESEA funds was also considered. Where obvious and flagrant social changes had occurred in a particular community, thereby obsoleting census tract data, careful examination of available school records was made in order to reach a more reliable estimate of status. Schools were then divided into two categories; the relatively advantaged and relatively disadvantaged.

All elementary schools were informed of project plans, and invited to become possible participants if sufficient interest existed among teaching and administrative staff. Random selection of participating schools was then made from among those accepting the invitation, with ten "advantaged" schools and ten "disadvantaged" schools being finally included. Random assignment of 16 schools (eight advantaged and eight disadvantaged) to the experimental treatment, and four schools (two advantaged and two disadvantaged) to a control situation free of any special in-service training program, was subsequently made.

Since voluntary participation of teachers was consistent with the underlying rationale of the project, and was also necessary as a condition attached to work in the school system, teachers in all 20 schools were asked to volunteer as possible project participants. From these volunteers, eight teachers were randomly selected from each

school, and assigned to either an experimental or control situation according to the assignment of their school. In all, 160 teachers were involved in the study, with 124 of them in experimental schools, and 36 of them in control schools.

Perhaps the most significant dependent variable of this project was measured by direct observer assessment of teacher classroom behavior, using the Flanders' Interaction Analysis. Trained raters were employed to assess each teacher's behavior, pre and post, as lessons of 15-20 minutes duration were conducted.

Each teacher was instructed to select or devise learning activities relevant to the on-going curriculum, representative of normal instructional procedures, and with objectives typical of the regular academic program. The teacher was told that the conduct of the lesson would be observed, and that some kind of learning activity involving both students and teachers should be planned. This was to avoid such inactive pursuits as silent reading or writing, formal written examinations, or independent study. These would be distinctly inappropriate for interaction analysis since they typically do not provide opportunities for living communication between teachers and students. Beyond this, no special instructions were provided.

Seven persons -- three undergraduate college students, two graduate students and two certified elementary school teachers -- were selected as raters. They underwent 15 hours of systematic training on the application of the Flander's procedures, following the program outlined in the "Interaction Analysis Training Kit - Level 1," published by Paul S. Amidon and

Associates, Inc., Minneapolis, Minnesota. During the training program, two checks of inter-rater reliability were made, using a modified Darwin Chi-square test -- a likelihood ratio criterion -- to test the hypothesis that the frequency distributions in any two rater matrices were the same. A special computer program, developed by Dr. Robert S. Rippey, a member of the faculty of the University of Chicago, was used in the actual statistical analysis.

The use of the modified Darwin Chi-square analysis to estimate inter-rater reliability did not provide an index of the precise strength of the reliability as would be expressed in a coefficient of correlation. It did provide a general indice of the extent of agreement between two observers. As Amidon points out in the Interaction Analysis Training Kit - Level 1, "no method is yet available for dealing with the problem of the reliability of sequential ratings."

Three dimensions of the Flanders' Analysis were used in this study: 1) Percentage of teacher talk; 2) Percentage of total teacher talk which was indirect; 3) Percentage of content.

Percentage of teacher talk represents that proportion of the total verbal activity involving teachers and students which is contributed by the teacher. Although such teacher talk does involve both indirect and direct types of teacher verbalization, and therefore inductively as well as deductively oriented statements, a significant increace in inductive teacher behavior as defined in the present project would tend to be accompanied by a decrease in the total proportion of teacher talk compared to student talk.

Table 1 shows the pre and post percentage of teacher talk observed for all experimental and control teachers. The total experimental and control groups show essentially comparable pre-proportions of teacher talk -- 65.60% for experimental, and 63.85% for control ($t = .52$, d.f. = 117, n.s.).

Table 1

Percentage of Teacher Talk, Pre - Post, by Experimental - Control Groups

Groups	N	Pre	Post	"t"
Experimental	95	65.60	51.03	11.47*
Control	24	63.85	64.99	.26
"t"	119	.52	4.36*	--

*Significant at .01 level

While experimental and control groups were thus equivalent at the beginning of the project, experimental teachers showed significantly less teacher talk at the end of the project than control teachers (51.03% and 64.99%; $t = 4.36$, d.f. = 117, $p. < .01$). In other words, teachers involved in the project became distinctly different from comparable teachers not involved in the project, i.e., project teachers as a group became definitely more inductive in this area than control teachers -- a change consistent with fundamental project objectives.

This total group of teachers was further divided into two sub-groups -- those whose pre-percentage of teacher talk was above the median for the entire

group (HIGH), and those whose pre-percentage of teacher talk was below the median for the group (LOW). The same analysis of pre vs. post percentage of teacher talk for experimental - control teachers, was made for these subgroups in order to determine whether project-associated change was in any way related to the initial, relative status of teachers with regard to this variable. Similar significant differences in post percentages were found for both HIGH and LOW groups, providing analogous evidence of desired project effects. It is therefore concluded that pre-disposition of teachers on this dimension is not significantly related to the measurable evidence of project effects.

Percentage of total teacher talk which was indirect was the second dimension of Flanders observation system analyzed for possible project effects. Change toward a more inductive approach would be manifested by a significant increment in the proportion of indirect as compared with direct teacher talk. The categories of teacher talk classified as "indirect" are all designed to accept, reward, praise, or elicit student talk, thereby promoting the kind of active student involvement so essential to inductive procedures.

Table 2 presents the pre and post percentages of indirect teacher talk observed for all experimental and control teachers. Percentages were essentially the same for both groups at the start of the experiment (59.36% compared to 57.18%; $t = .59$, d.f. = 117, n.s.).

TABLE 2

Percentage of Indirect Teacher Talk - Pre-Post

Groups	N	Pre	Post
Experimental	95	59.36	71.31
Control	24	57.18	48.61
"t"	119	.59	4.78*

*Significant at the .01 level.

At the conclusion of the experiment, a significant change occurred. Experimental teachers not only increased significantly the proportion of time they spend with indirect verbal activities from a pre of 59.36% to a post of 71.31% ($t = 4.76$, d.f. = 188, $p. < .01$). They also became significantly different ($t = 4.78$, d.f. = 117, $p. < .01$) from the control group on the post measurement. The control group devoted only 48.61% of its talking activities to indirect statements. Again, the experimental program has been associated with the emergence of a significant difference between participating and non-participating teachers, a difference which did not exist before the project, and which is in a direction consistent with basic project objectives.

A study of the same HIGH and LOW groups of experimental and control teachers revealed essentially the same results as observed for the total group.

The third dimension of observed teacher behavior used in this study was content, i.e., the proportion of teacher talk, including both direct and indirect kinds, devoted to information or content presented. Empahsis on

content, or formal subject matter, in the verbal behavior of a teacher conducting a live class of children, was thought to bear an inverse relationship to the general inductivity of that teacher.

Looking at Table 3, experimental and control teachers devoted essentially the same proportion of talk to content at the beginning of the program--

TABLE 3

Pre - Post Percentages of Content - Experimental and Control Groups

Groups	N	Pre	Post	"t"
Experimental	95	40.78	28.33	6.84*
Control	24	38.04	40.78	.53
"t"	119	1.01	4.08*	---

*Significant at the .01 level

experimental 40.78%, control 38.04% ($t = 1.01$, d.f. = 117, n.s.). On the post measure, however, there has been a significant change. Experimental teachers at that time devoted only 28.33% of their time to content, which is significantly less than the 40.78% showed by control teachers after the project ($t = 4.08$, d.f. = 117, $p. = < .01$).

Separate analyses were also made for the high-low sub-groups and the same trends emerged.

In summary, for all three dimensions -- teacher talk, indirect teacher

talk, and content -- experimental teachers showed significantly greater change toward inductive teaching styles than control teachers. These significant differences were observed for all teachers, whether they began the project with relatively high inductive patterns, or relatively low inductive patterns.

These same three dimensions of teacher behavior -- teacher talk, indirect teacher talk, and content -- were assessed for each teacher as she conducted a second, quite different type of lesson. This lesson involved a problem-solving task of an essentially non-academic kind, where the notion of one "correct" answer would be extremely difficult to sustain and defend, even for highly deductive teachers. In truth, the problem posed seldom admitted of one right answer, and this deliberate ambiguity was built into these materials in an effort to encourage teachers to display whatever inductive potential they might possess.

Tables 4, 5, and 6 summarize the pre and post percentage of teacher talk, indirect teacher talk, and content for the total experimental and control groups, respectively, when using the specially developed inductive materials. Several interesting facts deserve comment. First, in all cases, experimental and control groups were essentially equivalent when the project began.

Second, in each of the three areas, all teachers -- experimental and control -- initially showed significantly greater inductive tendencies in their behavioral response to these specially constructed lessons than they showed in response to the earlier regular academic lessons. Tables 7, 8, and 9 focus on these comparisons. Apparently these materials were

Flanders Interaction Analysis

Pre - Post Percentage Teacher Talk
By Experimental - Control Groups

Specially Developed Inductive Materials

TABLE 4

Groups	N	Pre	Post
Experimental	95	43.41	41.36
Control	24	47.04	43.80
"t"	119	.97	.70

Pre - Post Percentage Content
By Experimental - Control Groups

TABLE 5

Group	N	Pre	Post
Experimental	95	20.95	21.50
Control	24	23.17	21.71
"t"	119	1.10	1.10

Pre - Post Percentage Indirect/Direct Talk ratio
By Experimental - Control Groups

TABLE 6

Groups	N	Pre	Post
Experimental	95	72,88	74.46
Control	24	69.20	68.29
"t"	119	1.29	1.77

Pre - Post Percentage of Teacher Talk
By Type of Lesson

TABLE 7

Type of Lesson	N	Pre	Post
Experimental - Our Special Lesson	95	43.41	41.36
Experimental - Their Regular Academic Lesson	95	65.60	51.03

Pre - Post Percentage of Content
By Type of Lesson

TABLE 8

Type of Lesson	N	Pre	Post
Experimental - Our Special Lesson	95	20.95	21.50
Experimental - Their Regular Academic Lesson	95	40.78	28.33

Pre - Post Percentage of Indirect Talk
By Type of Lesson

TABLE 9

Type of Lesson	N	Pre	Post
Experimental - Our Special Lesson	95	72.88	74.46
Experimental - Their Regular Academic Lesson	95	59.36	71.31

successful in their "demand" for a more inductive approach. These teachers as a group were able to behave much more "inductively" than they typically behaved when working with regular academic materials. They were able to "adjust" to these new stimuli, hinting at least that teachers' conformity to a particular style of teaching, such as deductive-didactic, may not be as much a question of basic, unchanging personality, as it is of routine response to recurring kinds of stimuli, which appear easily satisfied by the same complex of teacher behaviors. Given some new and different stimuli, teachers can and do alter their classroom behaviors. The implications of this change potential for the in-service, re-education of teachers are profound, bearing directly on the feasibility of modifying teacher behavior.

Third, where teachers were using the non-academic lessons, there were no significant changes in any of the three areas for either control or experimental teachers, when the pre measures were compared with their appropriate post measures, or when experimental-control group comparisons are made on pre and post measures, respectively. Thus, no evidence exists that the experimental project had any significant impact on the teacher behaviors elicited by these strongly inductive materials.

Finally, even with the significant increase in inductive behavior earlier observed for experimental teachers using academic lessons, the level of inductivity finally attained with those regular lessons after the project, is still somewhat less than the level of inductivity these same teachers displayed before any project involvement when working with the special inductive materials. It is significantly less in two of the three areas -- teacher talk and content. (See Tables 7, 8, and 9.)

In the third area -- indirect teacher talk -- the level of inductivity post, using the academic lessons, was about the same as the level of inductivity pre, using the inductive lessons, (71.31% compared with 72.88% $t = .66$, d.f. = 188, n.s.).

A few hypotheses which at least point to possible areas of future study may now be suggested.

First, given the proper stimuli, teachers can behave with significantly greater inductivity than they usually evidence in normal classroom situations. They can perhaps "play" inductive roles when a real need arises. Second, normal academic lessons and materials, whether because of their intrinsic nature, the way they are perceived, or for other reasons, tend to elicit substantially less inductive behavior than most teachers are capable of sustaining. Third, the significant results associated with the present experimental in-service project suggest that substantially greater teacher inductivity can be promoted within the normal academic lesson. Such inductivity, however, remains somewhat less than the inductivity teachers are capable of showing with special inductively oriented materials relating to non-academic areas. Whether this remaining gap between the inductivity characterizing the non-academic materials as compared with the academic materials, can or should be closed is not known. The ultimate criterion for this decision, as for all decisions involving instructional procedures, must be found in the student learning that results. Such a question goes beyond the limits of the present study.

At least one possible explanation for the significant project results observed when teachers are working with academic lessons is also implied in what has already been said. The changes observed as experimental teachers became significantly more inductive in their implementation of academic materials, is not evidence of an alteration in the underlying, basic personality structure of the individual teacher; nor is it a matter of acquiring some entirely new, foreign characteristic not present in any form before the project involvement. It is rather, as suggested by the highly inductive response teachers were able to make immediately to the inductive materials, a new application of an existing potential to a type of situation that typically does not evoke such potential. Perhaps the main work of the project was to assist teachers in recognizing the appropriateness of inductive behavior to academic lessons, freeing teachers from the very restrictive set previously existing in the notion that for some reason, academic materials must be handled in a largely deductive fashion. The actual inductive behaviors themselves, or at least their dispositions, appeared already existent within most of the project teachers.